CARDEROCK DIVISION, NAVAL SURFACE WARFARE CENTER

TECH transfer UPDATE

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Technology Transfer and the Engineer

The laser, optical communications fiber, and the charge-coupled device are building blocks of photonics technology. They are also cornerstones of technology transfer, seemingly the hottest business strategy of the 1990s.

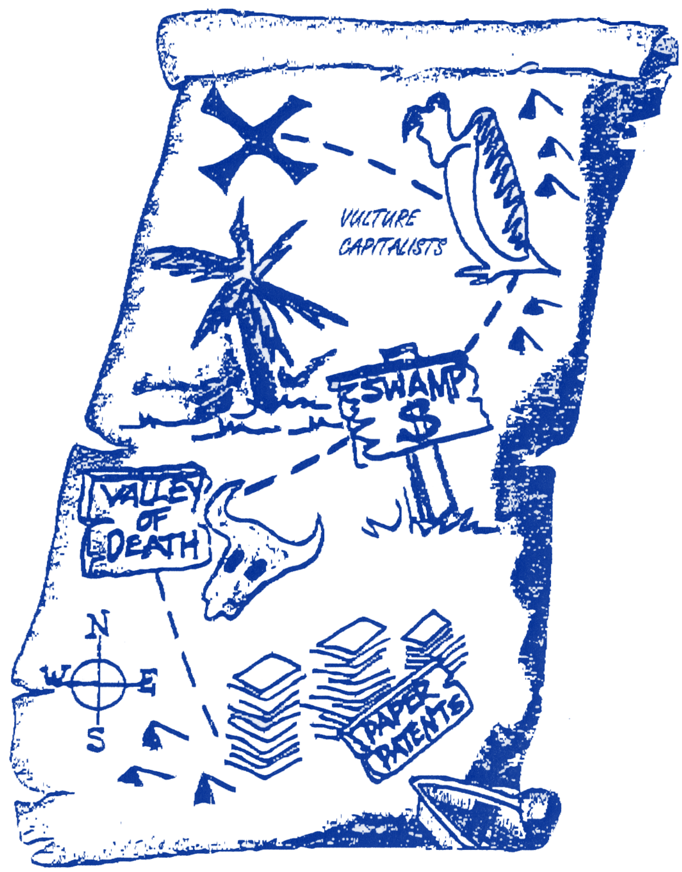
Simply stated, "technology transfer" is the movement of ideas from one group to another. This definition covers attempts to turn university students into productive engineers, to move military technology into commercial markets, to mold laboratory research into solutions for industry, or to merge the know-how of two or more companies that share a common technological goal.

The simple definition belies the difficult path that inventors and investors must tread in a technology-transfer relationship. Along the way, one must learn to recognize and avoid such hazards as the “Valley of Death,” the “Not Invented Here” syndrome and the “Vulture Capitalists.” What follows is travelers’ guide, gleaned from the experiences of those who have trod the path before and survived to tell their tales.

For many technology-based companies, this journey is the only road to survival; for others, it will simply lead the way to a more profitable future. For all concerned, it means embracing a new paradigm that flies in the face of what has been conventional wisdom.

Not Invented Here

Fifty years ago, life was simpler for technology companies. Corporate research and development centers



The tecnnology transfer “treasure map” is filled with hazards.

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attracted the key scientists and engineers in a given field, and the researchers had plenty of time to work on new ideas for products. Certainly, they watched the journals for exciting breakthroughs elsewhere, but for the most part, if it was not invented in-house, it was not important, or if it was a significant discovery, the in-house engineers could reinvent it with improvements designed to meet specific needs.

The photonic building blocks were "born" in such an atmosphere: lasers at the Hughes Research Laboratory; optical fiber at Corning Incorporated; and the CCD at AT&T Bell Labs.

Lee Rivers, now executive director of the National Technology Transfer Center in West Virginia, recalled his years in corporate research and development. "If it was worth doing, we did it ourselves," he said. "We had the world's greatest experts and didn't really do much hunting and gathering of outside technologies.

"The difference is, we didn't have the global competitors that we have today. And technology didn't move to the market as fast as it does today. You couldn't do it anymore within an individual company."

Curing a Syndrome

The first step toward that goal is to cure the "Not Invented Here" syndrome that keeps many companies from taking advantage of technological opportunities elsewhere. Typically these companies assume that outside technology cannot live up to the promises of its inventors or that it will not provide enough of a return on economic and human investments that would be required.

"If they're big companies, they can't believe there's anything they don't know," said Alastair Samson, president of ADR Spacelink$, a consulting firm that transfers European Space Agency technology. "If they're small companies, they are so busy scrambling to meet their payroll that they don't have time to consider outside technology."

The cure for the syndrome is a dose of reality, perhaps provided through the many success stories of new global competitors; it was in Europe and Asia that the concept of government-assisted technology transfer first showed its potential.

In Japan and Europe, for example, "a lot of the technology developers are government partnerships," noted Frank Penaranda, former NASA technology transfer director and now an official in the U.S. Commerce Department's Office of Technology Competitiveness. "They just realized very early on that the future of the country relies very heavily on their industry." And they used taxpayers' money to pay for research and developments to improve the industries that they decided are the most important, a strategy that U.S. "free-enterprise" proponents abhor.

Meanwhile, the U.S. Federal laboratories aimed their research at the military and at space. NASA began as early as the 1960s to transfer some of its space research to private industry, but on a severely circumscribed scale: "Federal labs only have the authority to produce technologies that impact a particular mission," Penaranda said. "Once it's accomplished, that's the end of our authority. To take that technology, improve it, make it ready for commercialization, was the job of industry."

Joseph G. Morone, dean of the Lally School of Management and Technology at Rensselaer Polytechnic Institute in Troy, N.Y., noted that "even in military conversion, the challenge is not to take technology off the shelf, but to take the capabilities and talent and see if you can aim it at some commercial targets."

American industry, however, hasn't historically excelled at this kind of transfer.

"(America is) an excellent nation in discovery, the best in the world at basic research," Penaranda said. "But we are not terribly good at anticipating what will sell in the consumer markets, so applied technology has not been our forte." As an example, he offers the CCD and the flat-panel display, which were born and initially developed in America but found commercial success with Japanese companies.

'Valley of Death'

American's lack of industrial policy is the first step toward what Mary Good, U.S. Commerce Department's undersecretary for technology, calls the Valley of Death, the gap between interesting technology and useful products. Without the basic ingredients for commercialization, innovative technologies often die in this valley, and passage through the valley is a standard part of any new technology business.

"There are basically two kinds of technology transfer," Penaranda said. "You have your hot zinger technologies that are shrink-wrapped and ready to market, and you have spin-offs that a lab has produced and which need to be incorporated into a larger system or product."

American industry, Penaranda points out, is eager to avoid the latter and license the former. One recent example of ready-to-market technology is the Air Force Phillips Laboratory's "Laser Medical Pen," a portable laser scalpel/cauterizing system that is the

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subject of a Cooperative Research and Development Agreement with Endeavor Surgical Products, which hopes to use the technology for civilian emergency medical applications.

"What most laboratory researchers have are 'paper patents,' neat ideas and fundamental items," said Jeff Bullington, executive director of Advanced Materials and Manufacturing Processes for Economic Competitiveness (AMMPEC). "If you make ten items and only three work, then [your technology] has too much risk and not enough value, so you can't entice private industry."

Saving Jobs

A more-developed idea, Bullington noted, commands a better price on the market. For example, if a military base is closing but it has some exciting and well-developed technology to transfer, it could require a licensee to hire the employees who helped develop the technology, thus saving jobs.

John T. Preston, former technology-transfer chief at the Massachusetts Institute of Technology, recently told the Massachusetts Technology Collaborative that one cause of the Valley of Death is that U.S. investors generally seek an 18-month turnaround on their investment, while novel technology can require three to five years of development.

"The stock market encourages mismanagement of technology," Preston argued. In Japan, on the other hand, investors are willing to wait longer.

Government contracts, like those offered in the U.S. Department of Defense and Department of Commerce Small Business Innovation Research programs, can go a long way toward helping the process. Such contracts can also encourage partnerships for technology transfer. For example, Kaigham J. Gabriel, microelectromechanical systems program manager for the Advanced Research Projects Agency, said an ARPA contract might include several component firms working together with a system integrator to accomplish some re-engineering to fit those components into a system.

Preston points out, however, that "the time horizon in politics is short," in the United States at least. A politician who exhorts Congress about the need to fund technology development must provide a tangible result to constituents whose tax dollars paid for the work, or risk being branded as a "tax-and-spend" rascal when seeking re-election.

All Technology Transfer Relies on a Common Foundation: People

"People, and their commitment, are the most important ingredients in successful tech transfer." says Milton Chang, president of New Focus Inc. in Sunnyvale, California. "Ideas are plentiful; there is plenty of technology developed every day. What distinguishes a successful one is that there is usually a real champion who keeps driving it."

Factors for Success

Business and marketing experts offer the following interrelated factors that determine the ultimate success of technology transfer.

◆**Attitude.** Radical innovation rarely originates within market leaders, Preston says, because they tend to resist the technology that will put them out of business. He points to Thomas Edison: As a young inventor, he created electric lighting, a technology that replaced the gas lamp corporations that had ignored him, but as electricity's market leader, he resisted George Westinghouse's then-innovative technique for producing electricity by alternating current.

Attitudes about the value of technology transfer also factor in its success. University of Wisconsin-Whitewater Professor Eliezer Geisler notes in an August 1995 study of technology transfer from the U.S. national laboratories that the most powerful predictors of technology transfer success are "the entrepreneurship of the laboratory's scientific workforce," the support of scientists' managers, and the perception by the receiving company's engineers and management that those scientists are willing to work with them.

◆**Management.** In Geisler's discussion of management as a top factor for successful technology transfer, he reports that to increase the chances of success, managers of both the transferring organization and the receiving organization must believe in the value of the transfer.

Thus, one could consider the example of two universities, one that encourages (or, at least, does not discourage) professors to "moonlight" and another that believes a professor's work should not be tainted by the aura of "commerce." Research from the former is more likely to gain commercial success not only because its champion is free to promote it but also because "management" believes the work is important.

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In fact, as universities scramble to fund their professors' research (and government labs scramble for their share of tax money), more are learning that "commerce" is not such a bad word. According to Preston, MIT's licensing income rose from $1.8 million in 1985 to $16.2 million (including equity in lieu of royalties) in 1992; many other universities have reported significant jumps, as have the U.S. national laboratories, other government agencies, and private research and development institutions.

Part of the reason for this increase is the proliferation of "technology matchmakers" or "technology management firms" around the world. It seems that every laboratory, university and small technology firm has a technology-transfer officer or outside agent whose job is to facilitate the movement of technology. The level of activity varies from referring callers to technology sources (e.g., the National Technology Transfer Center) to publishing lists of available technologies (e.g., the Federal Laboratory Consortium for Technology Transfer and the China-America Technology Corp.) to active pursuit of companies that can use the technology and complete management of the transfer process (e.g., ADR Spacelink$ and commercialization offices at each of the U.S. national laboratories).

At some level, the job of these managers may be to change attitudes and actually create an environment for technology transfer. This sort of matchmaking is "a very tough process, and a patient one: It takes a fair bit of time to actually find a receptor," said ADR Spacelink$'s Samson. "You can't just do that by using the Internet or those beautiful glossy brochures."

Preston believes even a marginal technology can be successfully implemented with good, aggressive management. "I would much rather have a first-rate management team and a second-rate technology than a first-rate technology and a second-rate management team," Preston said, "It offers a much higher chance of success."

Bullington noted that the first step to working with AMMPEC's 45 advisers is a business presentation where many scientists "feel very uncomfortable saying that when we get done it will run faster and jump higher. They are accustomed to hedging." Such marketing skills, experts say, are crucial to the success of a technology. AMMPEC takes the business skills development one step further, helping to create strategic industrial partnerships between small technology startups and major corporations that better understand distribution, marketing, and other business issues.

◆**Sustainable Advanced Patents.** If an inventor goes to a big company with a technology that could save millions of dollars a year, the first thing the big company will do is check the inventors' patents to determine whether it can get around them and steal the idea. "Strong intellectual property makes partners; weak intellectual property makes competitors," Preston noted.

Bullington added that universities and labs don't typically go through the expense of "due diligence" to consider issues that could affect a technology. As a technology manager, AMMPEC hires specialists to perform due diligence as an initial step in the transfer process.

Experts warn inventors to consider a related problem for technology that will cross international or cultural borders: Patent laws provide different levels of protection in different countries, and a patent in one country may offer little protection in another country.

International Issues

"Some Asian economies are relatively new, with new industrialization," explained Otto Schnepp, a University of Southern California professor and former science adviser at the U.S. Embassy in Beijing. "As a result, there is a lack of background experience and structure of law. There is a big problem of intellectual property being funneled off, turned over to other industry, and there isn't any redress." Language and cultural barriers may also exist at international borders, so such dealings should involve cultural intermediaries as a "buffer."

For example, the newly organized China-America Technology Corp. (CTC) provides such a buffer for U.S. companies that wish to transfer technology from Chinese institutions. "If I were an inventor in China, it's my life work that you're talking about," said CTC President Ngee-Pong Chang. "If it's being treated in cavalier fashion over here because here you think of it as a commodity, you could end up with a situation where an inventor feels he's been insulted."

◆**Passion.** For some scientists, the quest for knowledge and desire for others to appreciate their work is adequate to motivate technology transfer endeavors, but for many humans, money (or the promise of it, as in equity or stock) work better.

In technology-transfer relationships, passion is a function of each party's interest in the outcome of

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the transfer. "You can kind of simplify technology transfer as the transfer of commitment," said Milton Chang, president of New Focus Inc. "Then the question becomes, how does this scientist instill excitement in other people? In a transfer, the people the scientist is trying to excite are presumably less excited by technology and more excited about business."

The Inventor's Ego

Ignoring that basic tenet can prevent good technology from being transferred. "That can be a cause of problems, particularly where the owner of the technology is a relatively small company with a relatively arrogant inventor." ADR Spacelink$'s Samson said. "He thinks it is worth fabulous amounts of money."

An inventor who believes that creation is more important than engineering and/or management will create less passion among his or her partners (i.e., will try to keep more of the profits) than one who understands the value of engineering, design, management and marketing. The fallacy of the egotistical inventor's logic, Preston explained, is that a large percentage of a failed transfer is always smaller than a lesser percentage of a successful one.

◆**Quality Investors.** Inventors should seek investors who have at least two reasons for wanting the technology to succeed, Preston recommends. One could be for monetary gain, but the other should relate to industrial or other interests. For example, someone who has already invested in new drug technologies might see twofold benefits from investing in machine vision or spectroscopy technology that can improve pharmaccutical yields.

The investors must also understand, says Preston, how to capitalize technology businesses. Too much capital creates a "Taj Mahal effect," wherein executives splurge on office furniture and extras rather than engineering and design. Under-capitalization increases the amount of time required to produce a working product, leading to a longer time to market and, thus, a longer turn-around time.

◆**Momentum.** According to Preston, "Momentum, or a snowballing effect around a technology, increases the probability of success." One example from the 1980s is fiber optic telecommunications. Large corporations and private investors have gone out of their way to enable the transfer of technologies from laboratories to manufacturing lines.

In the 1990s, display technology and the Internet have momentum. Government attention has a large impact on momentum. When a government agency pronounces a technology to be especially crucial for the future, as with the U.S. "Critical Technologies" programs or Japan's "Center of Excellence" theme projects, it provides funding that investors soon match.

◆**Speed.** Time-to-market is a factor that can be tied to momentum. Preston quotes a study from a large electronics firm that showed that if it can get a new product to market one month earlier, it is worth more than the R&D cost of that product, while a six-month jump on the market provides a one-third boost in the product's lifetime profitability.

Penaranda noted, however, that technologies that move too quickly can suffer. For example, what good is a working videocassette recorder without the infrastructure to manufacture and deliver videotapes?

◆**Clusters.** New technology that exists in clusters, such as Tucson, Ariz., and Rochester, N.Y., is more likely to succeed. Preston says, because companies that locate close to technology generators and their fiercest competitors will adopt innovations more aggressively.

Clusters generally include at least one university, which provides a source of new research and employees; they

Companies that could use a new technology to save money or time may be blinded by their immediate struggles.

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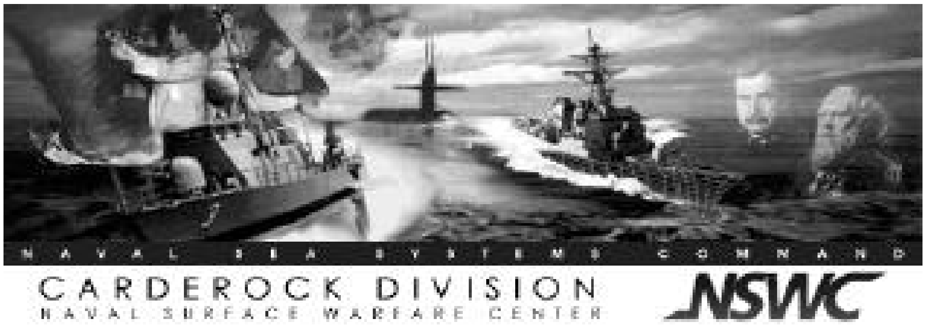

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often also involve incubator facilities or technology parks to encourage cross-fertilization of ideas and development of chicken-and-egg technologies like VCRs and videotapes.

For those who would be technology drivers, the voyage begins with an honest assessment of your technology's ultimate value. While there is no one path for technology transfer, knowledge of the potential pitfalls can simplify the journey. In the end, the success of a transfer depends on the commitment of those who are driving the process.

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